REMARKS

Claims 1-3, 5-7, and 9-28 are pending, with Claims 1 and 22 being independent. Claim 1 has been amended to clarify that the low-k dielectric layer is a carbon-doped glass low-k material. Support for the amendment can be found throughout the specification, for example, in the paragraph bridging pages 10 and 11. New Claims 26-28 have been added. Support for new claims 26 and 27 can be found throughout the specification, for example, on page 20, line 11 – page 23, line 10, and support for new claim 28 can be found throughout the specification, for example, on page 16, lines 7-11. No new matter has been added.

Reconsideration and allowance of the application are respectfully requested in light of the above amendment and the following remarks.

Rejection Under 35 U.S.C. § 102

- 1 -

Claims 1, 3, 5, 6, 9-13, 15, 16, 19-12, and 25 stand rejected under 35 U.S.C. § 102(a) as allegedly anticipated by U.S. Patent No. 6,090,304 ("Zhu"). The reasons for the rejection are stated on page 2 of the Official Action. The rejection is respectfully traversed.

Zhu discloses a method for improving the selectivity of dielectric layers to photoresist layers and base layers. (Abstract). Zhu discloses that, by way of example, the dielectric layer may be a silicon dioxide (SiO_2) layer, a borophosphosilicate glass (BPSG) layer, a tetra-ethyl-ortho-silicate (TEOS), phosphosilicate glass (PSG) layer, etc. (Column 5, Lines 19-23).

Claim 1, as amended, recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer comprising supporting a semiconductor substrate in a chamber of a plasma etch reactor, the semiconductor substrate having a low-k dielectric layer of a carbon-doped glass low-k material and an overlying mask layer. An oxygen-free single-fluorocarbon etching gas is supplied to the chamber and the etching gas is energized into a plasma state, the etching gas consisting essentially of at least one nitrogen reactant, a single fluorocarbon reactant represented by C_nF_m wherein n is at least 4 and m is at least 6, and optional carrier gas, the fluorocarbon reactant and nitrogen reactant being supplied to the chamber at flow rates such that the fluorocarbon reactant flow rate is less than the nitrogen reactant flow rate. Exposed portions of the low-k dielectric layer are etched with the plasma so as to etch openings in the low-k dielectric layer with the plasma while providing a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5. The plasma etch reactor comprises a dual frequency parallel plate plasma reactor having a showerhead electrode and a bottom electrode on which the substrate is supported.

"A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987); MPEP § 2131.

It is respectfully submitted that Claim 1 is not anticipated by Zhu as each and every element set forth in the Claim 1 is not found in Zhu. In particular, Zhu does not disclose a low-k dielectric layer of a carbon-doped glass low-k material.

Accordingly, withdrawal of this rejection under 35 U.S.C. § 102(a) is respectfully requested.

- II -

Claims 1, 3, 5-7, 9-13, 15-17, 19-21, and 25 stand rejected under 35 U.S.C. § 102(a) as allegedly anticipated by U.S. Patent No. 6,117,786 ("Khajehnouri"). The reasons for the rejection are stated on page 2 of the Official Action. The rejection is respectfully traversed.

Khajehnouri discloses a semiconductor manufacturing process wherein deep and narrow 0.6 micron and smaller openings are plasma etched in doped and undoped silicon oxide and wherein the etching gas includes fluorocarbon, ***oxygen*** and nitrogen reactants. (Abstract). Khajehnouri further discloses that by decreasing or eliminating ***oxygen*** in the etching gas mixture it is possible to form ***tapered*** openings. (Column 3, Lines 26-28). Khajehnouri discloses aspect ratios (which differ from etch rate selectivities) of at least 5:1 (Column 4, Lines 30-31). Khajehnouri additionally discloses that the silicon oxide can be formed in a variety of ways and can include dopants such as F, B, P, As, etc.; for example, the silicon oxide can be undoped silicate glass (USG), boron phosphorus silicate glass (BPSG), phosphorus silicate glass (PSG), spin on glass (SOG), doped or undoped TEOS, fluorinated silicon oxide (SiOF), thermal oxide, or other form of silicon oxide. (Column 5, Lines 6-13).

It is respectfully submitted that Claim 1 is not anticipated by Khajehnouri as each and every element set forth in the Claim 1 is not found in Khajehnouri. In particular, Khajehnouri does not disclose: (1) a low-k dielectric layer of a carbon-doped glass low-k material, or (2) an overlying mask layer wherein the etch rate

selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer is at least about 5.

Accordingly, withdrawal of this rejection under 35 U.S.C. § 102(a) is respectfully requested.

Rejection Under 35 U.S.C. § 103

- I -

Claim 2 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Khajehnouri in view of U.S. Patent No. 6,251,770 ("Uglow"). The reasons for the rejection are stated on page 3 of the Official Action. The rejection is respectfully traversed.

Uglow, cited as teaching that underlying barrier layers are typically SiN or SiC, does not cure the above-noted deficiencies of Khajehnouri. Claim 2 is dependent upon Claim 1, and thus includes all of the limitations of Claim 1. Accordingly, for at least the reasons stated above concerning the deficiencies of Khajehnouri regarding Claim 1, withdrawal of this ground of rejection is respectfully requested.

- II -

Claim 14 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Khajehnouri. The reasons for the rejection are stated on page 4 of the Official Action. The rejection is respectfully traversed.

Claim 14 is dependent upon Claim 1, and thus includes all of the limitations of Claim 1. Accordingly, for at least the reasons stated above concerning the deficiencies of Khajehnouri regarding Claim 1, withdrawal of this ground of rejection is respectfully requested.

- III -

Claim 18 stands rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over Khajehnouri. The reasons for the rejection are stated on page 4 of the Official Action. The rejection is respectfully traversed.

Claim 18 is dependent upon Claim 1, and thus includes all of the limitations of Claim 1. Claim 18 further recites that the etching gas consists essentially of C_5F_8, N_2 and Ar, while it is respectfully submitted that Khajehnouri does not disclose C_5F_8. Accordingly, for at least this reason and the reasons stated above concerning the deficiencies of Khajehnouri regarding Claim 1, withdrawal of this ground of rejection is respectfully requested.

- IV -

Claims 22-24 stand rejected under 35 U.S.C. § 103(a) as allegedly unpatentable over U.S. Patent No. 6,506,680 ("Kim") in view of U.S. Patent No. 6,284,149 ("Li"). The reasons for the rejection are stated on pages 5-6 of the Official Action. The rejection is respectfully traversed.

Kim relates to a method of forming dual-damascene metallic interconnections with low dielectric constant insulating layers. (Column 1, Lines 9-12). Kim discloses etching an upper insulating interlayer with high selectivity to a lower insulating interlayer using a plasma gas that may be CxFy series with a high C/F ratio such as C_3F_8, C_4F_8, C_5F_8, etc.; or a mixture of CxFy series and CHxFy series such as CH_2F_2, CH_3F, etc; or otherwise, it may be CxFy or CHxFy/CxFy series mixed with at least one of O_2, N_2, or CO. (Column 6, Lines 40-55). Kim further discloses that the upper insulating interlayer comprises an inorganic substance of a low dielectric constant without containing Si--H, Si--C and Si--CHx bonds such as FSG composed of SiOF

with a dielectric constant κ of about 3.5, SiO_2 with a dielectric constant κ of about 4, or TEOS (tetraethylorthosilicate glass) with a dielectric constant κ=about 3.9. (Column 5, Lines 56-65).

Li discloses a plasma etching process for etching a carbon-based low-k dielectric layer in a multi-layer inter-level dielectric. (Abstract). Li discloses plasma etching a carbon-based material with an etching gas including a fluorocarbon gas, an oxygen-containing gas, such as oxygen, and nitrogen. (Column 5, Lines 28-31). Li discloses a hard-mask etch step followed by a BCB etch step. (Column 7, Lines 56-65). Li further discloses that the BCB etch step is believed to be the most critical one and that a satisfactory etch was achieved using an oxygen-containing gas such as the conventional O_2 as the principal etchant for the carbon-based BCB; however, since BCB contains a small amount of silicon, the etch rate is substantially increased by the inclusion of a substantially smaller amount of a fluorocarbon, such as C_4F_8. (Column 9, Lines 54-65).

Claim 22 recites a process for etching a low-k dielectric layer with selectivity to an overlying mask layer comprising supporting a semiconductor substrate in a chamber of a plasma etch reactor, the semiconductor substrate having a low-k dielectric layer of a doped glass low-k material and an overlying mask layer. An oxygen-free etching gas is supplied to the chamber and the etching gas is energized into a plasma state, the etching gas consisting essentially of C_4F_8, CF_2H_2, N_2 and optionally Ar, the C_4F_8, CF_2H_2 and N_2 being supplied to the chamber at flow rates such that the total C_4F_8 and CF_2H_2 flow rate is 30% or less of the N_2 flow rate. Exposed portions of the low-k dielectric layer are etched with the plasma so as to etch openings in the low-k dielectric layer with the plasma while providing a etch rate

selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5.

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations. MPEP § 2142.

It is respectfully submitted that the combination of Kim and Li does not disclose or suggest all the claim limitations. Again, Kim discloses etching using a plasma gas that may be CHxFy/CxFy series mixed with at least one of O_2, N_2, or CO, and Li discloses etching using an ***oxygen-containing*** gas. Specifically, the combination of Kim and Li teaches using an oxygen containing etch gas and does not suggest the claimed combination of features which includes: (1) a low-k dielectric layer of a doped glass low-k material, (2) an overlying mask layer, (3) an ***oxygen-free*** etching gas, (4) the etching gas consisting essentially of C_4F_8, CF_2H_2, N_2 and optionally Ar, (5) the C_4F_8, CF_2H_2 and N_2 being supplied to the chamber at flow rates such that the total C_4F_8 and CF_2H_2 flow rate is 30% or less of the N_2 flow rate, and (6) a etch rate selectivity of the etching rate of the low-k dielectric layer to the etching rate of the mask layer of at least about 5.

Accordingly, withdrawal of this rejection under 35 U.S.C. § 103(a) is respectfully requested.

Conclusion

For at least the reasons noted above, reconsideration of the claims and allowance of the subject application is earnestly solicited. In the event that there are any questions relating to this application, it would be appreciated if the Examiner would telephone the undersigned attorney concerning such questions so that prosecution of this application may be expedited.

In the event any further fees are due to maintain pendency of this application, the Examiner is authorized to charge such fees to Deposit Account No. 02-4800.

Respectfully submitted,

BURNS, DOANE, SWECKER & MATHIS, L.L.P.

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By: _____
Asaf Batelman
Registration No. 52,600

P.O. Box 1404
Alexandria, Virginia 22313-1404
(703) 836-6620